

## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification<sup>6</sup>:B25F 1/04, B25G 1/08, B26B 1/02, B25B  
13/56

A1

(11) International Publication Number:

WO 97/29887

(43) International Publication Date:

21 August 1997 (21.08.97)

(21) International Application Number: PCT/US97/02300

(22) International Filing Date: 14 February 1997 (14.02.97)

(30) Priority Data:

08/599,948	14 February 1996 (14.02.96)	US
08/698,653	16 August 1996 (16.08.96)	US

(71) Applicant: BONDHUS CORPORATION [US/US]; 1400 East Broadway, Monticello, MN 55362 (US).

(72) Inventors: BONDHUS, John, R.; 7336 Alladin Avenue N.W., Buffalo, MN 55313 (US). BLACKSTON, Michael, D.; 14375 8th Avenue North, Plymouth, MN 55447 (US). BONDHUS, Barry; 100 South Maple Street, Lester Prairie, MN 55354 (US). BURDA, Dennis, A.; 1343 48th Street N.E., Buffalo, MN 55313 (US). PETROSKE, Mark, L.; 12076 165th Avenue S.E., Becker, MN 55308 (US).

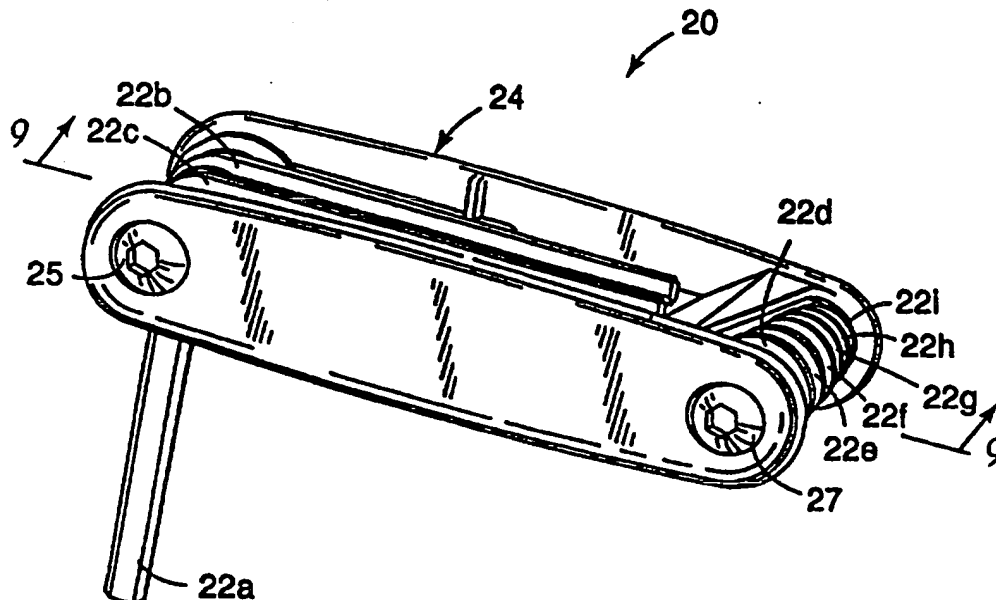
(74) Agent: SCHWAPPACH, Karl, G.; Mueting, Raasch, Gebhardt &amp; Schwappach, P.A., P.O. Box 581415, Minneapolis, MN 55458-1415 (US).

(81) Designated States: CA, JP, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published

With international search report.

(54) Title: FOLDING HAND TOOL SET



## (57) Abstract

A folding hand tool set having a one-piece, completely integral, plastic handle and a plurality of hand tools rotatably mounted thereto. The one-piece, completely integral, plastic handle is preferably constructed from a fiber reinforced thermoplastic. In one embodiment, spacers are provided for mechanically isolating the hand tools. The folding hand tool set is capable of transmitting more than 110.0 Newton meters of torque without compromising the integrity of the one-piece, completely integral plastic handle. The present invention is also directed to a one-piece, completely integral, plastic handle for receiving hand tools. The handle can withstand at least 30 Newton meters of torsional force without compromising the integrity of the handle.

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## **FOLDING HAND TOOL SET**

### **Field of the Invention**

5           The present invention is directed to a one-piece, completely integral, plastic handle for a folding hand tool set, more particularly, to a one-piece, completely integral, plastic handle containing a plurality of hand tools that permits high levels of torque to be generated without compromising the integrity of the plastic handle.

10

### **Background of the Invention**

          Hand tools are typically discrete items that can be easily misplaced. To overcome this problem, various hand tool set holders have been developed in which a plurality of hand tools is secured in a moveable manner so as to avoid individual tools being lost. However, in order to accommodate a  
15           sufficient number of tools into a single holder or container, the overall sizes of the tools tend to be reduced and the handle is often relied upon to transmit torque through the tool to the workpiece.

          Various types of handles for tool sets have been developed, such  
20           as two-piece metal and plastic handles, and one-piece stamped metal handles. Current metal handles are subject to corrosion and add significant weight and cost to the tool sets. Current two-piece plastic handles lack the strength to transmit higher levels of torque required for certain applications. Finally, one-piece handles, whether metal or plastic can be more expensive to assemble than  
25           their two-piece counterparts.

### **Summary of the Invention**

The present invention is directed to a folding hand tool set having a one-piece, completely integral, plastic handle constructed of a thermoplastic and a plurality of hand tools rotatably mounted thereto. In the preferred  
5 embodiment, the thermoplastic is fiber reinforced and the folding hand tool set is capable of transmitting more than 110 Newton-meters of torque without compromising the integrity of the one-piece, completely integral, plastic handle, more preferably more than 120 Newton-meters of torque, and most preferably more than 135 Newton-meters of torque.

10 The present invention is also directed to a one-piece, completely integral, plastic handle for a folding hand tool set constructed of a thermoplastic. In an embodiment where the thermoplastic is fiber reinforced, the handle can withstand at least 30 Newton-meters of torsional force without compromising the integrity of the handle.

15 The one-piece, completely integral, plastic handle on the folding hand tool set includes first and second elongated side walls arranged in a generally parallel configuration. The sidewalls are joined along a center portion of an inner surface thereof by a center rib. First and second mounting ends are located on opposite ends of the handle. Outer surfaces of the elongated side  
20 walls form a gripping surface. The center rib is positioned to form first and second recesses with the side walls for receiving hand tools along a longitudinal axis of the folding hand tool set. The center rib further includes a first reinforcing web proximate the first mounting end to form a portion of a second recess. A second reinforcing web may be located proximate the second  
25 mounting end for forming a portion of the first recess.

The plurality of hand tools is rotatable from a first position within the first or second recesses to a second position at least 270° from the first position. It will be understood that the hand tools may be rotated more or less than 270° without departing from the scope of the present invention. The first  
30 and second webs form end stops for the second position of the hand tools. In an embodiment in which a hand tool is rotated approximately 270° against an end

stop, the end stop reduces the risk that the tool will collapse into the handle when high levels of torque are applied.

One or more of the hand tools may be separated by a spacer or washer. In the preferred embodiment, the spacer or washer is fixedly engaged with the handle so that torque generated from the rotation of a tool from the first position to the second position is not transmitted to adjacent tools.

The one-piece, completely integral, plastic handle is preferably constructed from fiber reinforced thermoplastics. The fibers are preferably aligned or oriented along the longitudinal axis of the handle. Suitable reinforcing materials include aramid, carbon, glass, polyester or mica fibers, or some combination thereof.

In one embodiment, the gripping surface curves inward toward the center rib proximate the center portion to facilitate gripping by the user. Alternatively, the gripping surface may be straight or curve outward proximately the center portion. The center rib may include a center reinforcing member proximate the center portion of the first and second sidewalls. In one embodiment, the reinforcing member is a 'S'-shaped curve in the center rib.

A pair of opposing raised shoulders may be located on opposing inner surfaces of the first and second sidewalls proximate the first and second mounting ends. One or more side wall supports may be located along a portion of an inner surface of a sidewall and a portion of the center rib. The side wall supports may also serve to offset the hand tools from the inner surface of the sidewalls to facilitate removal from the handle. The sidewalls of the handle are preferably curved or bowed outward along the top and bottom edges thereof proximately the center portion so that the height or thickness of the sidewalls is greater at the center than at the mounting ends.

A variety of hand tools may be included in the folding hand tool set of the present invention, including hex wrenches, screwdrivers, Torx® drivers, open end wrenches, box end wrenches or some combination thereof.

As used in this application the expression "compromise to the integrity of the handle" shall mean permanent damage such as inelastic

deformation, visible cracks, or catastrophic failure.

### **Brief Description of the Drawings**

Figure 1 is a perspective view of an exemplary folding hand tool set with a one-piece, completely integral, plastic handle;

Figure 2 is a top view of an exemplary one-piece, completely integral, plastic handle for a folding hand tool set;

Figure 3 is a front view of the handle of Figure 2;

Figure 4 is a bottom view of the handle of Figure 2;

Figure 5 is a rear view of the handle of Figure 2;

Figure 6 is a sectional view of the handle of Figure 2;

Figure 7 is a sectional view of the folding hand tool set of Figure 2 with one of the hand tools rotated approximately 180° from the handle;

Figure 8 is a top view of the exemplary folding hand tool set of Figure 7;

Figure 9 is a sectional view of the folding hand tool set of Figure 1 with one of the tools rotated approximately 270° from the handle;

Figure 10 is a top view of the exemplary folding hand tool set of Figure 9;

Figure 11 is a left end view of the handle of Figure 3;

Figure 12 is a right end view of the handle of Figure 3;

Figure 13 is an alternate embodiment of a one-piece, completely integral, plastic handle for a folding hand tool set;

Figure 14 is a bottom view of the handle of Figure 13;

Figure 15 is a top view of an alternate folding hand tool set utilizing the handle of Figure 13;

Figure 16 is a sectional view of the folding hand tool set of Figure 15;

Figure 17 is a left end view of the handle of Figure 13;

Figure 18 is a right end view of the handle of Figure 13;

Figure 19 is a top view of the spacer shown in Figure 16;

Figure 20 is a top view of an alternate space shown in Figure 16;

Figure 21 is a bottom view of an alternate handle with integrally formed spacers; and

Figure 22 is a sectional view of a folding hand tool set utilizing the handle of Figure 21.

### **Detailed Description of the Preferred Embodiments**

Figure 1 is a perspective view of an exemplary folding hand tool set 20 in which a plurality of hand tools 22a-22i are retained to a one-piece, completely integral, plastic handle 24 by fasteners 25, 27. The fasteners 25, 27 preferably are threaded proximally only a distal end thereof. The hand tools 22b-22i are located in a first storage position within the handle 24. The hand tool 22a is rotated to a second extended position approximately 270° from the one-piece, completely integral, plastic handle 24. It will be understood that the hand tool 22a can be rotated approximately 180° to operate similarly to a screwdriver (see Figures 7 and 8), or a variety of other positions.

The folding hand tool set 20 is preferably assembled by arranging the tools 22a-22c in an upright position in a fixture to simulate the second extended position 270° relative to the handle 24, such as illustrated in Figure 1. The tools 22d-22i are located in an upright position in an adjacent fixture to simulate a second extended position 90° relative to the handle 24, so that the handle 24 may be engaged with all of the tools 22a-22i simultaneously. The fasteners 25, 27 are then inserted through the handle 24 and tools 22a-22i and secured. The fasteners 25, 27 preferably do not rotate with the tools 22a-22i.

Although the embodiment illustrated in Figure 1 is shown with a hex-shaped wrench, it will be understood that a variety of hand tools may be included in the folding hand tool set of the present invention, including screwdrivers, Torx® drivers, open end wrenches, box end wrenches or some combination thereof.

Figures 2-5 and 11-12 illustrate an exemplary one-piece, completely integral, plastic handle 24 for retaining a plurality of hand tools, such

as illustrated in Figure 1. As illustrated in Figures 2 and 4, the one-piece, completely integral, plastic handle 24 includes a first side wall 26 joined to a second side wall 28 by a center rib 30. The center rib 30 extends along the inside surface 32, 34 of the first and second side walls 26, 28 at a center portion 36.

5 The center portion 36 extends generally the full length of the center rib 30 as measured along longitudinal axis L. The distal ends of the first and second side walls 26, 28 form first and second mounting ends 40, 43 for receiving a plurality of hand tools.

The first mounting end 40 includes a pair of holes 42, 44 which  
10 are aligned across an opening 46. The outside surface of the second side wall 28 includes a hexagonal recess 48 generally concentric with the hole 42 for receiving a fastener (see Figure 5). The first side wall 26 includes a circular recess 50 concentric with the hole 44 for receiving the head of a fastener for engagement with the hexagonal fastener in the recess 48 (see Figure 3). The  
15 inside surfaces of the first and second side walls 26, 28 include a pair of opposing raised shoulders 52, 54.

Similarly, the second mounting end 43 includes a pair of opposing  
holes 60, 62 aligned across an opening 64. The second side wall 28 includes the hexagonal recess 66 generally concentric with the hole 60 for receiving a  
20 hexagonal fastener (see Figure 5). The first side wall 26 includes a circular recess 68 concentric with the hole 62 for receiving the head of a fastener that meets with the hexagonal fastener in the recess 66 (see Figure 1). The inner surfaces 32, 34 of the first and second side walls 26, 28 respectively, include raised shoulders 70, 72.

25 The shoulders 52, 54, 70, 72 serve to offset the hand tools 22a-22i from the inner surface 32, 34, to provide additional strength to the first and second mounting ends 40, 43 and to maintain the hand tools 22a-22i parallel to a longitudinal axis L during rotation.

Tool size indicators 90, 91, 92 are preferably molded into the  
30 center rib 30 of the one-piece, completely integral, plastic handle 24. First and second side wall supports 104, 106 provide additional structural support to the



side walls 26, 28, respectively, and transmit force from the side walls 26, 28 to the center rib 30. The side wall supports 104, 106 also space the tools 22a-22i from the inner surfaces 32, 34 of the sidewalls 26, 28 to facilitate removal of the hand tools.

5                   As best illustrated in Figure 2, the first and second side walls 26, 28 are curved inward toward the center rib 30 generally along the center portion 36. The handle 24 is wider proximate the mounting ends 40, 43. It will be understood that the sidewalls 26, 28 may alternately be straight or curved outward proximate the center portion 36. As best illustrated in Figures 3 and 5,  
10                   the sidewalls 26, 28 of the handle 24 are curved or bowed outward along the top and bottom edges thereof so that the height or thickness of the sidewalls is greater at the center portion 36 than at the mounting ends 40, 43.

                  The sidewalls 26, 28 have greater thickness at the mounting ends 40, 43 due to the raised shoulders 52, 54, 70, 72, as well as additional  
15                   thermoplastic material proximate the recesses 48, 50, 66, 68. The greater thickness increases resistance to breakage proximate the first and second mounting ends 40, 43. The narrowness of the handle 24 along the center portion 36 provides for some flexibility in this area.

                  The curves of the handle 24 enhance comfort for the user but also  
20                   serves to cantilever some of the torsional forces that are generated when using the tool set 20 from the mounting ends 40, 43 toward the center rib 30, thereby increasing the ultimate strength of the handle 24. Consequently, longitudinal as well as lateral displacement/distortion occurs when the forces that are generated at the first and second mounting ends 40, 43 of the handle 24 are transferred  
25                   toward the center portion 36 of the handle 24.

                  The center rib 30 has an S-shaped curve 80 proximate the center portion 36 to provide additional strength to the plastic handle 24 (see also Figures 7 and 9). The center rib 30 includes a first reinforcing web 82 located proximate the first mounting end 40. The edge of the reinforcing web 82 serves  
30                   as an end stop 86 for the hand tools 22d-22i. Similarly, the center rib 30 includes a second reinforcing web 84 located proximate the second mounting

end 43. The edge of the second mounting web serves an end stop 88 for the hand tools 22a-22c (see Figure 9). The end stops 86, 88 may be curved or angled to accommodate different diameter tools. For example, the end stop 86 is angled more toward the center portion 36 opposite the 1/4 inch tool than opposite the  
5 3/16-inch tool.

Additional tool size indicators 93-98 are molded into the bottom side of the center rib 30, as shown in Figure 4. A second side wall support 100 may be formed proximately the second side wall 28 along the bottom edge of the center rib 30. Similarly, a first side wall support 102 may be formed opposite the  
10 second side wall support 100.

Figure 5 is a rear view of the one piece plastic handle 24 of Figure 2. A mounting hole 105 may be provided in the second sidewall 28 for attaching instructional information to the hand tool set 20 and for hanging the tool on a tool belt or tool rack.

15 Figure 6 is a sectional view of the handle 24 of Figure 2 showing the first and second side wall supports 104, 106. It will be understood that the precise shape of the side wall supports may vary considerably without departing from the scope of the present invention.

Figure 11 is a left end view of the handle 24 of Figure 3 showing the placement of the first sidewall support 104 and the end stop 86. Figure 12 is a right end view of the handle 24 of Figure 3 showing placement of the first  
20 sidewall support 102 and the end stop 88.

The present one-piece, completely integral, plastic handle 24 is preferably constructed from a fiber reinforced thermoplastic formed by injection  
25 molding to form a discrete structure or article. The reinforcing fibers are preferably oriented or aligned generally parallel to the longitudinal axis L during the injection molding process to enhance the strength of the handle 24 using injection molding techniques known in the art. Other fiber orientations may be desirable for some applications. The thermoplastic resists cold, heat and  
30 corrosive chemicals while providing a comfortable non-slip grip. It will be understood that a variety of non-reinforced plastics may be used instead of the

fiber reinforced thermoplastic, although lower levels of torque are likely.

Thermoplastics known to be suitable for use in the present invention include acrylonitrile-butadiene-styrene, acetal, acrylic, polyamide nylon 6-6, nylon, polycarbonate, polyester, polyether etherketone, polyetheride, polyether sulfone, polyphenylene sulfide, polyphenylene oxide, polystyrene, polysulfone, and styrene acrylonitrile. Suitable reinforcing materials include aramid, carbon, glass, polyester or mica fibers, or some combination thereof. The gripping surface preferably has a slightly course or pebbled surface finish in order to provide a non-slip surface. The hand tools 22a-22i are preferably constructed from high grade tool steel and heat treated to provide maximum torque.

It will be understood that the present handle 24 may be constructed in a variety of sizes, depending upon the number and size of the hand tools and the desired strength of the handle 24. While no specific industry standards exist, common dimensions for handles used in folding hand tool sets are set forth in Table 1 below:

Table 1

Overall Handle Length	Height of Handle Profile (see Figures 3 and 5)
0.1397-0.1524 m (5.5-6.0 inches)	0.0254-0.0381 m (1-1.5 inches)
0.1080 m (4.25 inches)	0.0254 m (1 inch)
0.0889 m (3.5 inches)	0.0191 m (0.75 inches)
0.0762 m (3 inches)	0.0191 m (0.75 inches)

Figures 7 and 8 illustrate an exemplary folding hand tool set 20 in which one of the hand tools 22a is rotated approximately 180° from the one-piece, completely integral, plastic handle 24. As illustrated in the sectional view of Figure 7, the center rib 30, first reinforcing web 82 and end stop 86 form a first recess 74. The center rib 30, second reinforcing web 84 and end stop 88 form a second recess 76. Fastener 25 retains hand tools 22d-22i in the handle 24. Fastener 27 retain the hand tools 22a-22c in the handle 24. As illustrated in Figure 8, the 1/4" designation 92 is exposed, indicating that the 1/4" hex tool has been rotated from the first storage position inside the first recess 74 to a second

extended position. The second side wall support 106 serves to guide the hand tool 22a from the first recess 74 to the second extended position.

Figures 9 and 10 illustrate the folding hand tool set 20 of Figures 7 and 8 in which the hand tool 22a has been rotated approximately 270° relative to the one-piece, completely integral, plastic handle 24. The hand tool 22a contacts the end stop 88 of the second reinforcing web 84. The end stop 88 serves to retain the hand tool 22a at right angles relative to the handle 24. When rotated 270°, the end stops 86, 88 of the first and second reinforcing webs 82, 84 retain the hand tools at approximately 90° relative to the handle 24, thereby allowing the user to generate the maximum torque while minimizing the possibility that the hand tool will collapse toward the center rib 30 and pinch the user's fingers. The second side wall support 106 serves to guide the hand tool 22a from the first recess 74 to the second extended position. It will be understood that the end stops 86, 88 may be adjusted to permit more than 270° of rotation.

Figures 13, 14, 17 and 18 illustrate an alternate one-piece, completely integral, plastic handle 120 for retaining a plurality of hand tools 22a-22i (see Figure 15). The handle 120 of Figures 13 and 14 generally corresponds to the handle of Figure 2 and 4, except that a plurality of slots 122a-122g are formed in the center rib 124 proximate the reinforcing webs 126, 128.

The slots 122a-122g are designed to receive distal portions 130, 131 of spacers 132, 134 shown in Figures 19 and 20, respectively. The spacers 132, 134 each have a center hole 136, 138 through which the fasteners 140, 142 extend (see Figure 16). The spacers 132, 134 may be constructed from a variety of materials, such as metal or a polymeric material.

The distal portion 130 of the spacer 132 is sized to accommodate the distance between the axis of the fastener 140 and the slots 122c-122g. The distal portion 131 of the spacer 134 is sized to accommodate the distance between the axis of the fastener 142 and the slots 122a-122b. The engagement of the distal portions 130, 131 with the slots 122a-122g prevents the spacers 132, 134 from rotating. Consequently, each of the tools 22a-22i of the folding hand

tool set 20' of Figures 15 and 16 can be rotated from a first position within one of the recesses 74', 76' to an extended position without transmitting torque to adjacent tools 22a-22i. The fasteners 140, 142 preferably do not rotate with the rotation of the tools 22a-22i. Mechanically isolating each tool 22a-22i facilitates  
5 usage of the hand tool 22' with one hand.

Figure 21 illustrates an alternate one-piece, completely integral, plastic handle 150 for retaining a plurality of hand tools 22a-22i, illustrated in Figures 22. The handle 150 of Figure 21 generally corresponds to the handles of Figures 2 and 14, except that a plurality of spacers 152a-g are integrally formed  
10 in the handle 150. The spacers 152a-g extend from the reinforcing webs 154, 156 of the center rib 158 so that center holes 160 in the spacers 152a-g are aligned with the holes 162, 164, 166, 168 in the handle 150. As illustrated in Figure 22, fasteners 170, 172 extend through the tools 22a-22i, the center holes 160 and the holes 162-168 in the handle 150. Each of the tools 22a-22i of the  
15 folding hand tool set 20" of Figure 22 can be rotated from a first position within one of the recesses 74", 76" to an extended position without transmitting torque to adjacent tools.

### Examples

20 Two sizes of a folding hand tool set 20 each having a one-piece, completely integral, plastic handle were compared to various other folding tool set constructions to determine the maximum torque at which the integrity of the handle was compromised. The one-piece, completely integral, plastic handles were constructed of a glass fiber reinforced nylon.

25

#### Example 1

A series of hand tools with an overall handle length of approximately 0.1080 m (4.25 inches) and a handle height of approximately 0.0254 m (1.0 inch) were tested. Each hand tool set forth from Table 2 below  
30 was placed into a round metal holder that completely encased the handle to within one inch of the tool that was tested. The 1/4" hand tool for each handle

was rotated 90° from the handle and placed into a hex-shaped hole in a strain gauge transducer until approximately 1" of the tool remained exposed. When pressure was applied to each handle in a rotational fashion, torque was transmitted to the strain gauge and the value of that torque was digitally displayed on the strain gauge readout. The pressure was increased until that handle was permanently damaged or broken, as summarized in Table 2 below.

Table 2

Hand Tool Style	Torque at which permanent damage was done to handle	Torque at which handle broke or split apart
Two-part zinc die cast handle	--	87.11 Newton-meters
One-part stamped metal handle	74.12 Newton-meters	100.22 Newton-meters
Two-part plastic handle	--	95.02 Newton-meters
Two-part metal handle w/ plastic grips	--	72.88 Newton-meters
One-piece, completely integral, plastic handle	--	135.69 Newton-meters

The one-piece plastic handle transmitted 42.8% more torque than that two-part plastic handle tested and 35.3% more torque than the one-part stamped metal handle.

### Example 2

A series of hand tools with an overall handle length of 0.0889 m (3.5 inches) and a handle height of approximately 0.01905 m (0.75 inches) were tested according to the method of Example 1, the results of which are set forth in Table 3 below.

Table 3

Hand Tool Style	Torque at which permanent damage was done to handle	Torque at which handle broke or split apart
Two-part zinc die cast handle	--	62.03 Newton-meters
One-part stamped metal handle	--	88.35 Newton-meters
Two-part metal handle w/ plastic grips	--	59.77 Newton-meters
One-piece, completely integral, plastic handle	--	130.27 Newton-meters

The one-piece, completely integral, plastic handle transmitted 47.5% more torque than the one-part stamped metal handle.

### Example 3

A series of handles for various folding hand tool sets with the tools removed were subject to a torsional test, including the present one-piece, completely integral, handle constructed from a glass reinforced nylon. One end of each test handle was gripped to a depth of 0.0254 m (1.0 inch) by a retaining fixture attached to a strain gauge transducer. The other end was gripped to a depth of 0.0254 m (1.0 inch) by a retaining fixture attached to a means for inducing a torque along the length of the handle. When pressure was applied to each handle in a rotational (torsional) fashion, torque was transmitted to the strain gauge and the value of that torque was digitally displayed on the strain gauge readout. The torque was increased until the handle being tested broke, split or collapsed, as summarized in Table 4 below.

Table 4

Hand Tool Style	Handle size	Torque at which handle broke, split or collapsed
Two-part zinc die cast handle	0.1080 m X 0.0254 m	27.46 Newton-meters
One-part stamped metal handle	0.1080 m X 0.0254 m	21.47 Newton-meters
One-piece, completely integral, plastic handle	0.1080 m X 0.0254 m	39.43 Newton-meters
Two-part zinc die cast handle	0.0889 m X 0.01905 m	23.16 Newton-meters
One-part stamped metal handle	0.0889 m X 0.01905 m	15.93 Newton-meters
One-piece, completely integral, plastic handle	0.0889 m X 0.01905 m	38.41 Newton-meters

As is clear from Table 3, the present one-piece, completely integral, plastic handle of the present invention withstood significantly more torque than prior handle constructions.

The present invention has now been described with reference to several embodiments described herein. It will be apparent to those skilled in the art that many changes can be made in the embodiments without departing from the scope of the invention. Thus, the scope of the present invention should not be limited to the structures described herein, but only to structures described by the language of the claims and the equivalents to those structures.



What is claimed is:

1. A folding hand tool set, comprising:  
a one-piece, completely integral, plastic handle constructed from a thermoplastic including first and second elongated side walls arranged in a generally parallel configuration and joined along a center portion of an inner surface thereof by a center rib, first and second mounting ends and an outer gripping surface, the center rib being positioned to form first and second recesses for receiving hand tools along a longitudinal axis, the center rib further having a first reinforcing web proximate the first mounting end forming a portion of the second recess and a second reinforcing web proximate the second mounting end forming a portion of the first recess; and  
a plurality of hand tools rotatably mounted to the first and second mounting ends, the hand tools being rotatable from a first position within the first or second recesses to a second extended position.
2. The apparatus of claim 1 wherein the first and second reinforcing webs form end-stops for the second position of at least one of the hand tools.
3. The apparatus of claim 1 wherein the second position of at least one of the hand tools is approximately 270 degrees from the first position.
4. The apparatus of claim 1 wherein the thermoplastic comprises a fiber reinforced thermoplastic such that torque of at least 110.0 Newton-meters may be transmitted to one of the hand tools without compromising the integrity of the one-piece, completely integral, plastic handle.
5. The apparatus of claim 1 wherein the thermoplastic comprises a fiber reinforced thermoplastic such that torque of at least 120.0 Newton-meters may be transmitted to one of the hand tools without compromising the integrity of the one-piece, completely integral, plastic handle.

6. The apparatus of claim 1 wherein the one-piece, completely integral, plastic handle has a length comprising about 0.1080 meters.

7. The apparatus of claim 6 wherein the thermoplastic comprises a fiber reinforced thermoplastic such that torque of at least 135.0 Newton-meters may be transmitted to one of the hand tools without compromising the integrity of the one-piece, completely integral, plastic handle.

8. The apparatus of claim 1 wherein the one-piece, completely integral, plastic handle has a length comprising about 0.0889 meters.

9. The apparatus of claim 1 wherein at least a portion of the gripping surface is curved inward toward the center rib proximate the center portion.

10. The apparatus of claim 1 wherein the center rib further includes center reinforcing means proximate the center portions of the first and second side walls.

11. The apparatus of claim 10 wherein the reinforcing means comprises a "s-shaped" curve proximate the center portions.

12. The apparatus of claim 1 wherein the hand tools comprise a plurality of hex-shaped wrenches.

13. The apparatus of claim 1 wherein the thermoplastic is selected from a group consisting of acrylonitrile-butadiene-styrene, acetal, acrylic, polyamide nylon 6-6, nylon, polycarbonate, polyester, polyether etherketone, polyetheride, polyether sulfone, polyphenylene sulfide, polyphenylene oxide, polystyrene, polysulfone, and styrene acrylonitrile.

14. The apparatus of claim 1 wherein the thermoplastic

comprises a fiber reinforced thermoplastic.

15. The apparatus of claim 1 wherein the fibers are oriented generally parallel to the longitudinal axis of the handle.

16. The apparatus of claim 1 wherein the fibers are selected from a group consisting of aramid, carbon, glass, polyester or mica, or combinations thereof.

17. The apparatus of claim 1 further comprising a pair of opposing raised shoulders on opposing inner surfaces of the first and second sidewalls proximate the first and second mounting ends.

18. The apparatus of claim 1 further comprising at least one side wall support extending along a portion of an inner surface of a sidewall and a portion of the center rib.

19. The apparatus of claim 18 wherein the at least one side wall support provides an offset of at least one hand tool from an inner surface of a sidewall.

20. The apparatus of claim 1 wherein the sidewalls include top and bottom edges that curve generally outward proximately the center portion.

21. The apparatus of claim 1 further including spacer means for mechanically isolating at least two adjacent hand tools.

22. The apparatus of claim 21 wherein the spacer means comprise spacers integrally formed in the handle.

23. The apparatus of claim 21 wherein the spacer means comprise discrete spacer elements fixedly engaged with the handle and positioned between at least two of the plurality of hand tools proximate at least one of the mounting ends.

24. The apparatus of claim 1 further including spacer elements having distal portions fixedly engaged with the handle and a body portion positioned between each of the plurality of hand tools.

25. The apparatus of claim 1 wherein the handle further comprises a plurality of spacers integrally formed in the handle, the spacers being positioned between each of the plurality of hand tools.

26. A folding hand tool set, comprising:  
a one-piece, completely integral, plastic handle constructed from a fiber reinforced thermoplastic including first and second elongated side walls arranged in a generally parallel configuration and joined along a center portion of an inner surface thereof by a center rib, first and second mounting ends and an outer gripping surface, the center rib being positioned to form first and second recesses for receiving hand tools along a longitudinal axis, the center rib further having a first reinforcing web proximate the first mounting ends forming a portion of the second recess and a second reinforcing web proximate the second mounting end forming a portion of the first recess; and

a plurality of hand tools rotatably mounted to the first and second mounting ends, the hand tools being rotatable from a first storage position within the first or second recesses to a second extended position, such that a torque of more than 110.0 Newton-meters may be transmitted to one of the hand tools without compromising the integrity of the one-piece, completely integral, plastic handle.

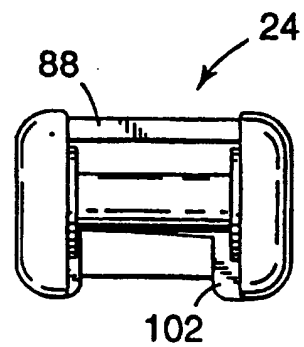
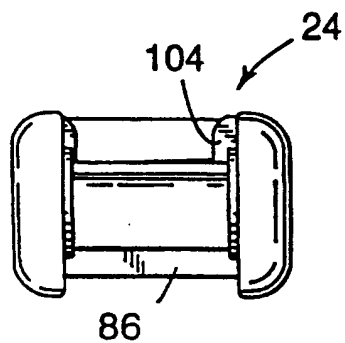
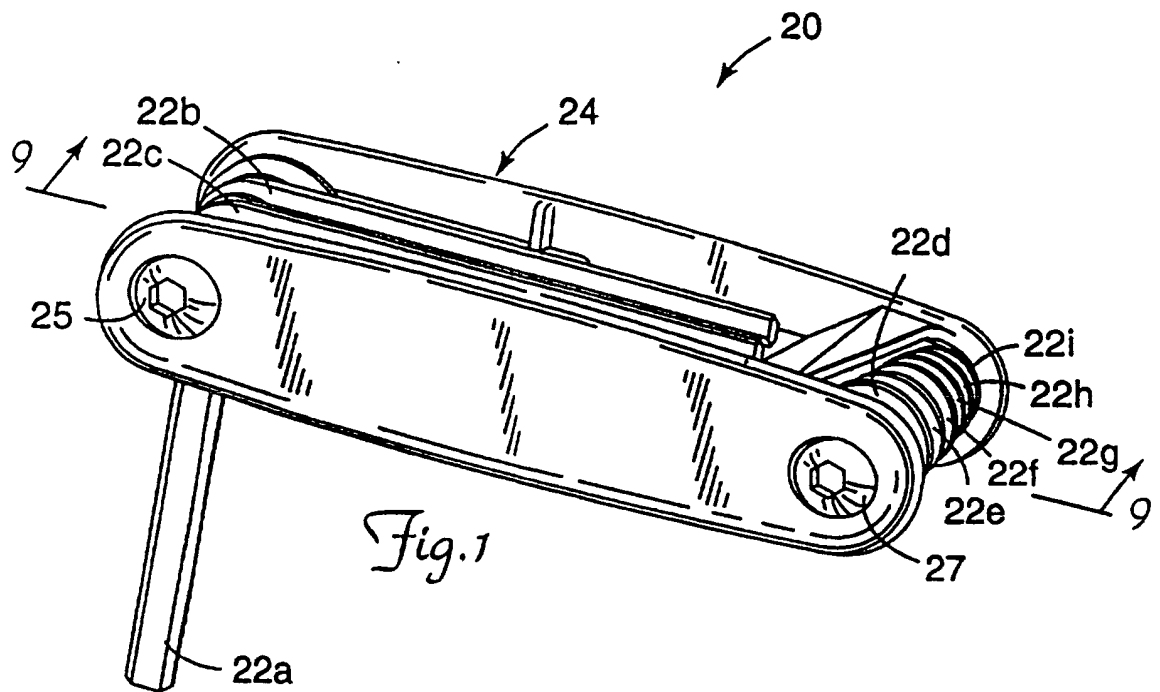
27. The apparatus of claim 26 further including spacer means

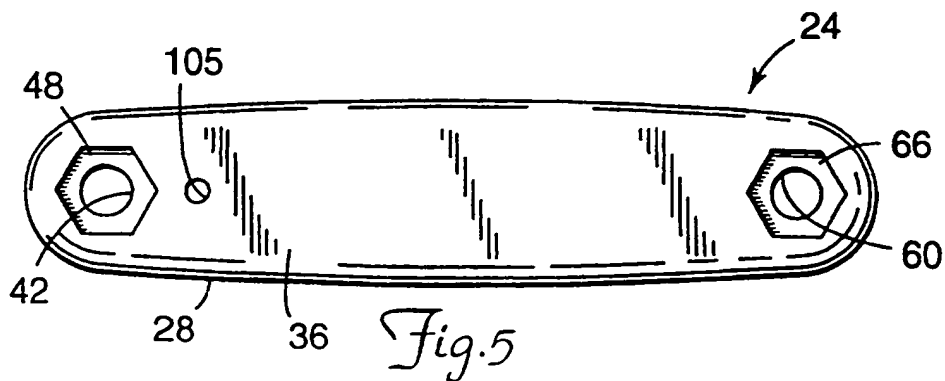
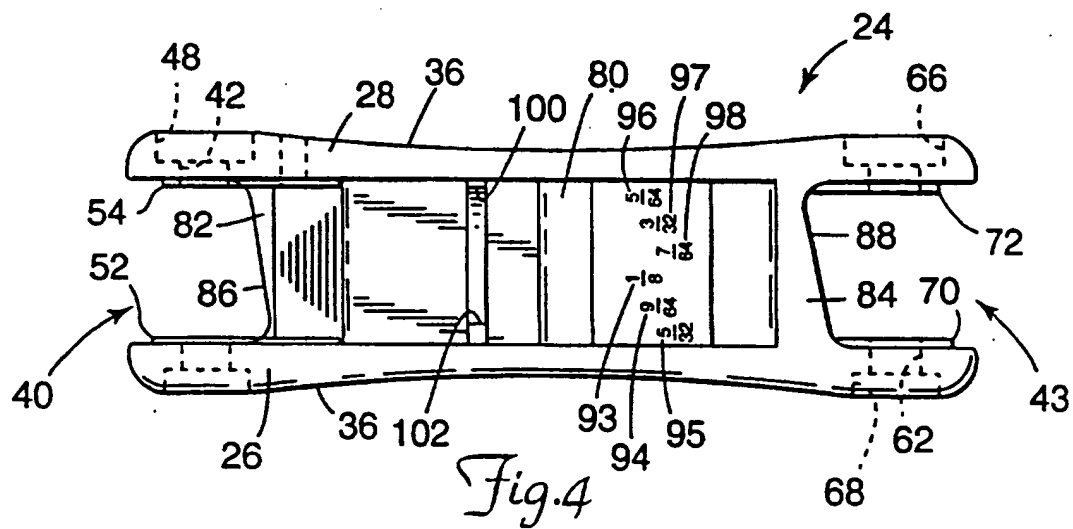
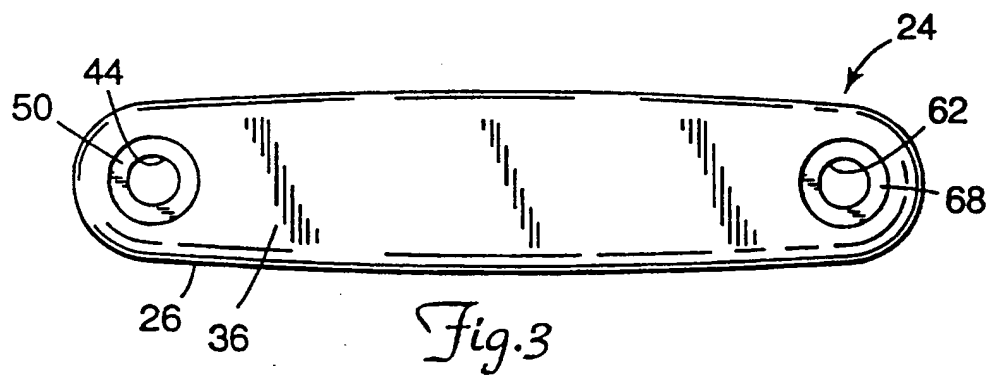
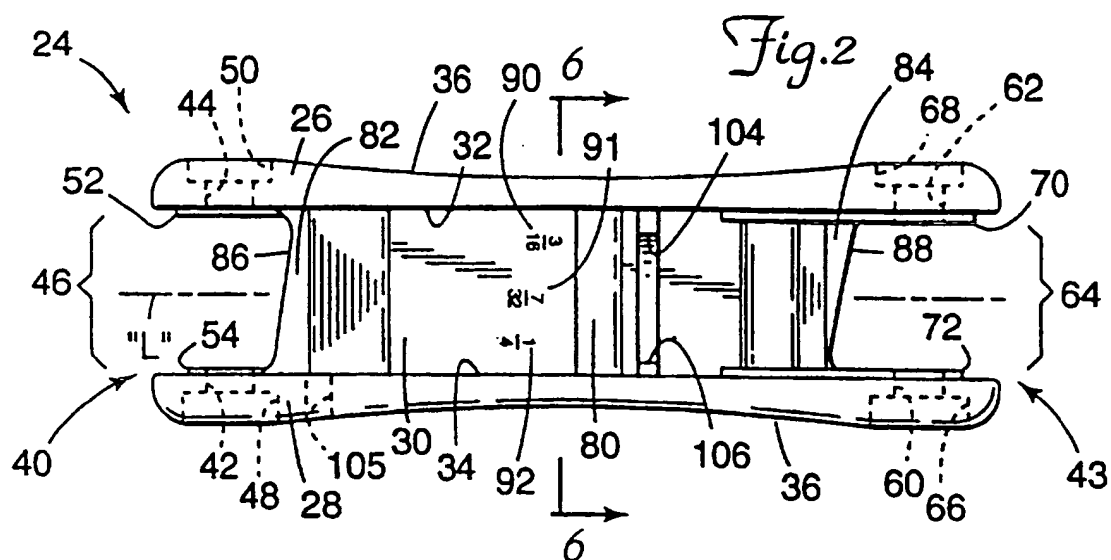
for mechanically isolating at least two adjacent hand tools.

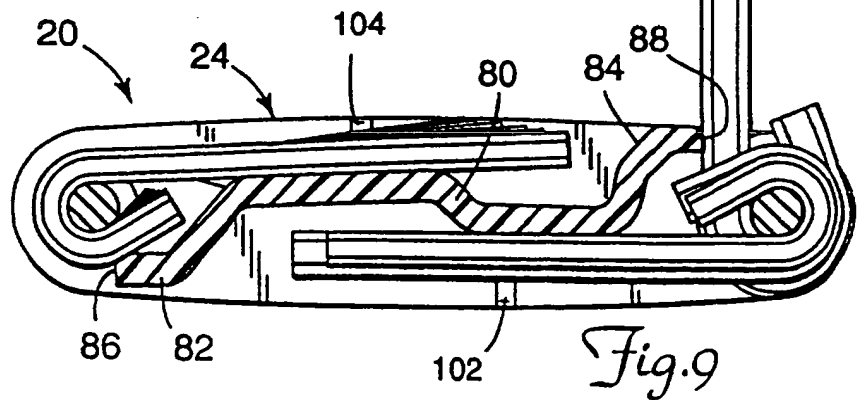
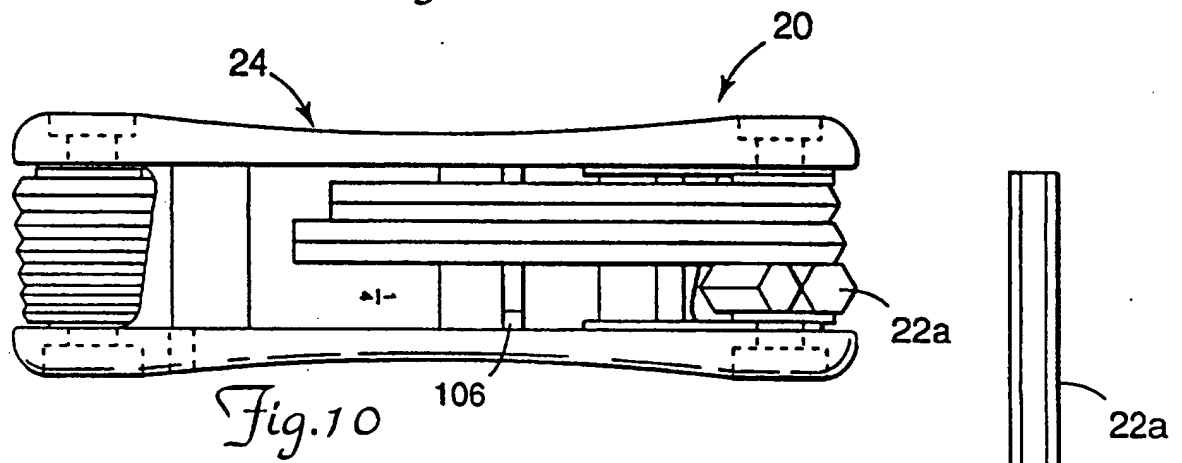
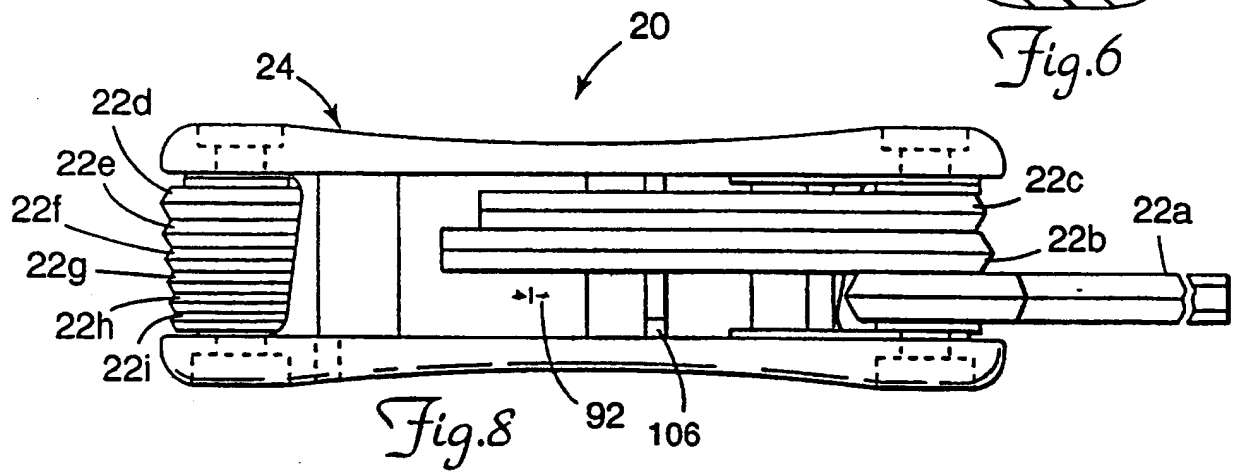
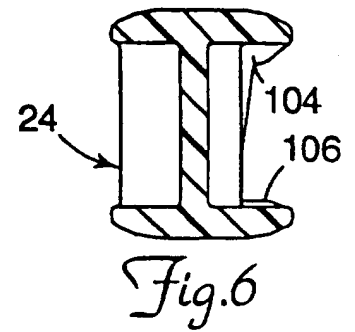
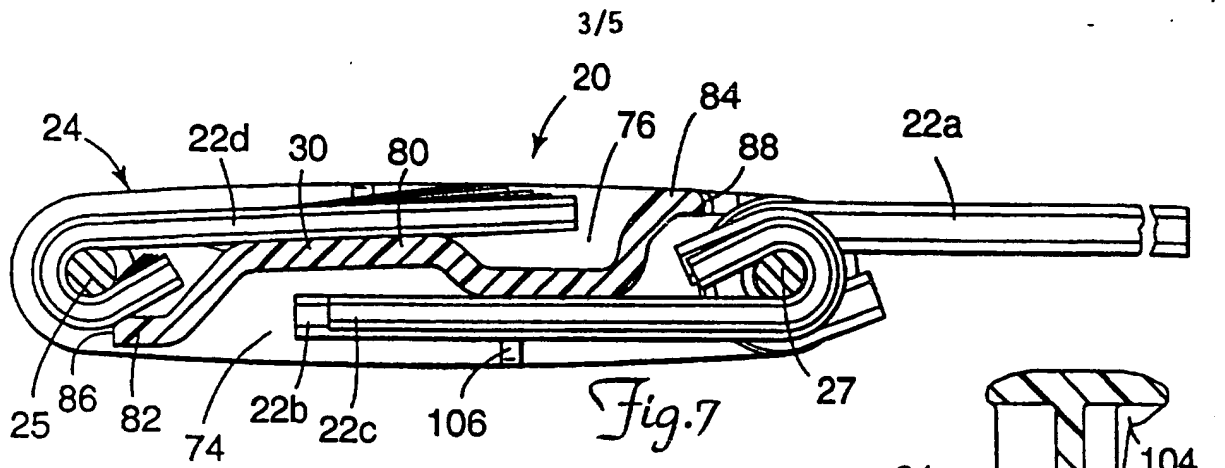
28. A handle for a folding hand tool set, comprising a one-piece, completely integral, plastic handle constructed from a thermoplastic including first and second elongated side walls arranged in a generally parallel configuration and joined along a center portion of an inner surface thereof by a center rib, the center rib including center reinforcing means proximate the center portions of the first and second side walls, first and second mounting ends for receiving a plurality of hand tools and an outer gripping surface, the center rib being positioned to form first and second recesses for receiving hand tools along a longitudinal axis, the center rib further having a first reinforcing web proximate the first mounting ends forming a portion of the second recess and a second reinforcing web proximate the second mounting end forming a portion of the first recess.

29. The apparatus of claim 28 wherein the thermoplastic comprises a fiber reinforced thermoplastic such that at least 30 Newton-meters of torsional force may be applied without compromising the integrity of the one-piece, completely integral, plastic handle.

30. The apparatus of claim 28 further including spacer means for mechanically isolating at least two adjacent hand tools.









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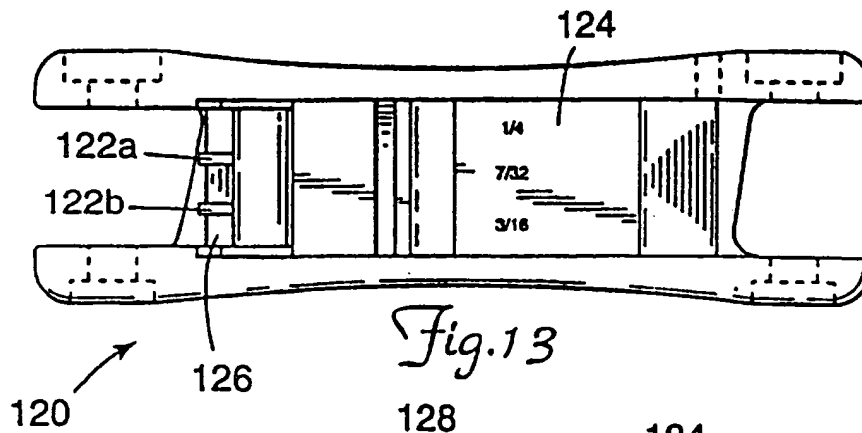


Fig. 13

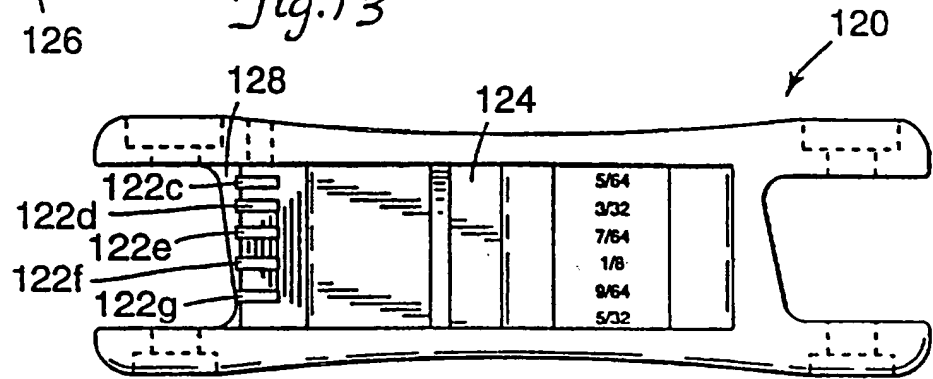


Fig. 14

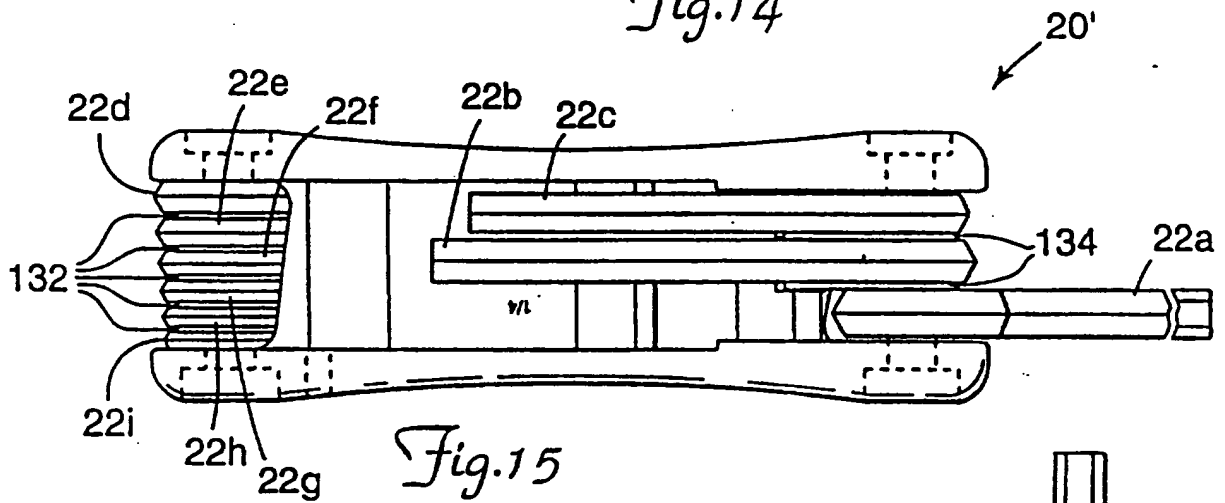


Fig. 15

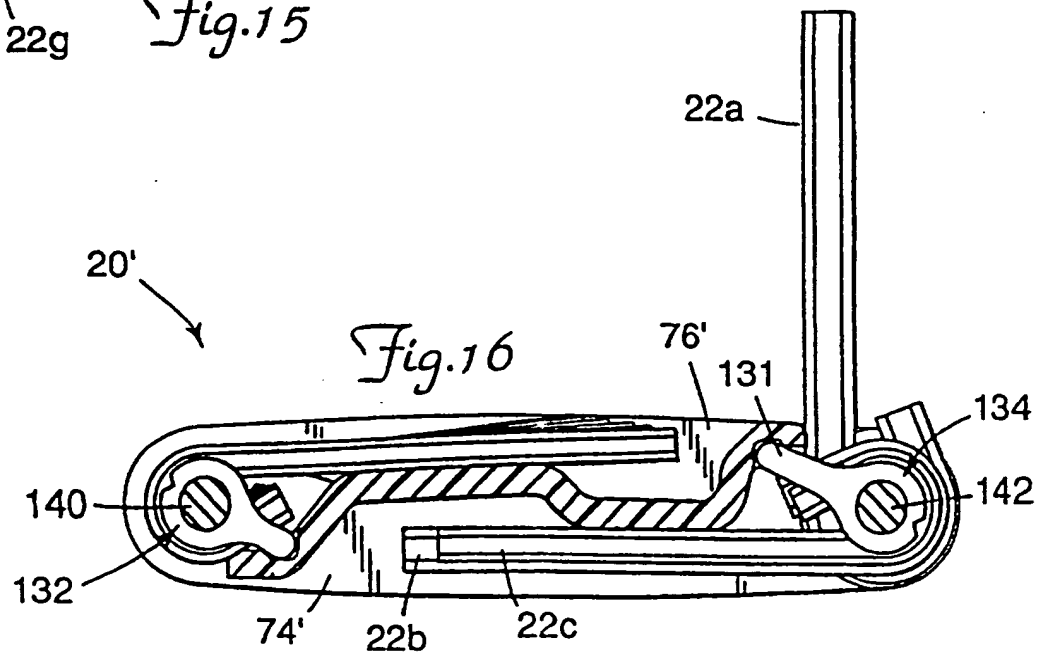
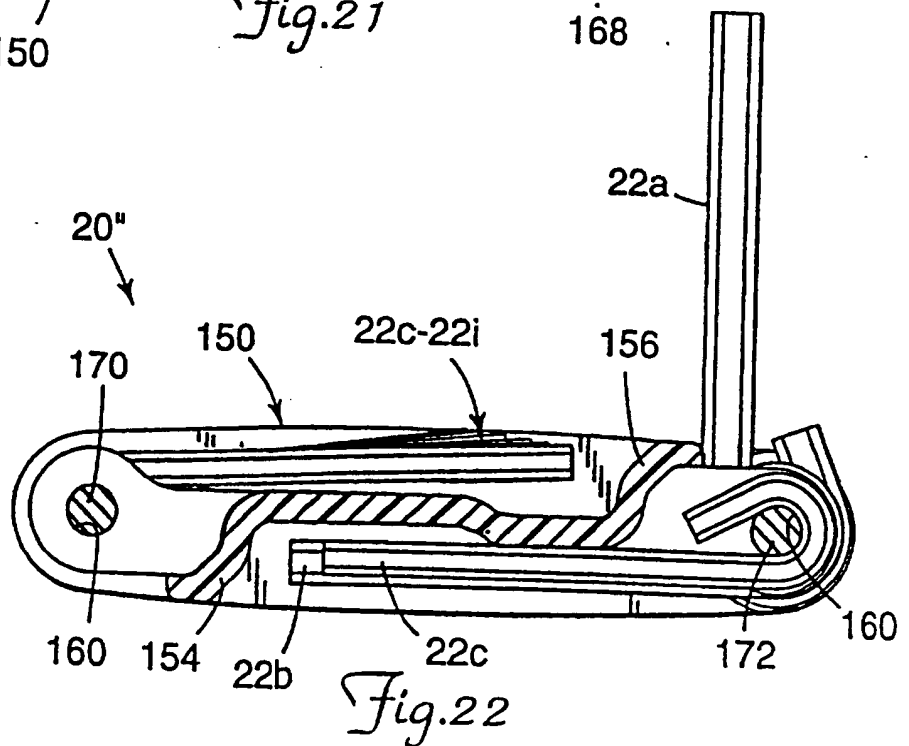
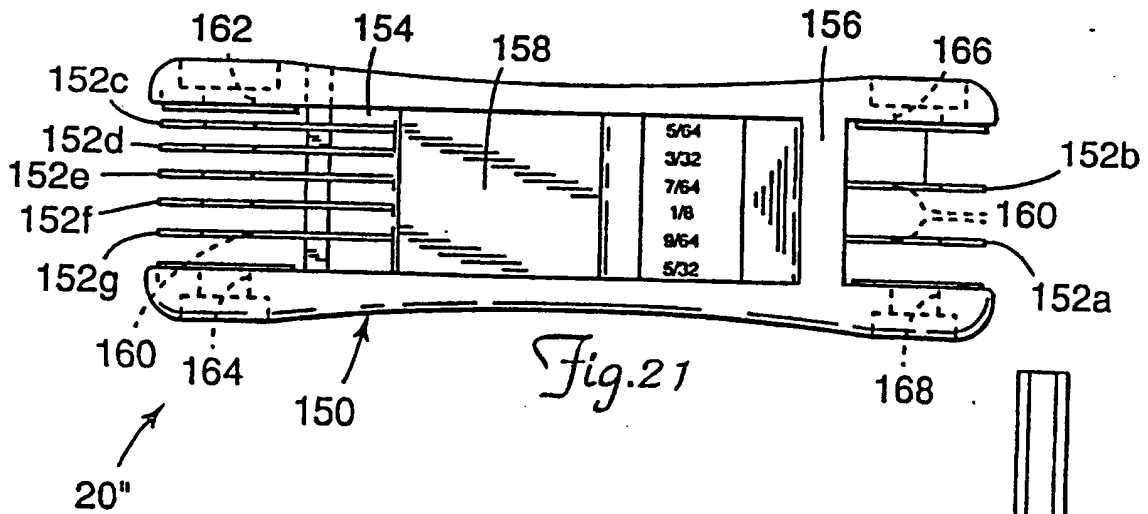
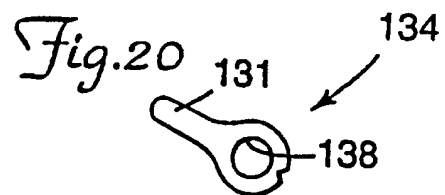
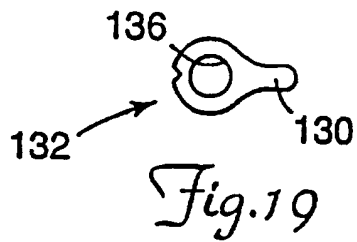
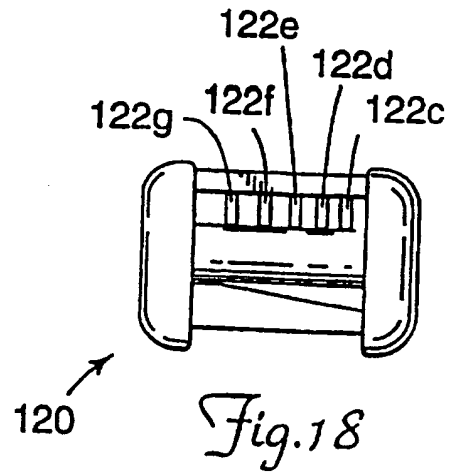
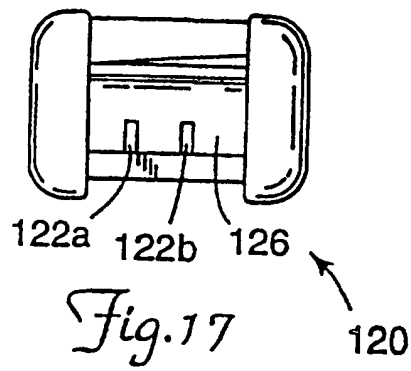


Fig. 16

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A. CLASSIFICATION OF SUBJECT MATTER  
IPC 6 B25F1/04 B25G1/08 B26B1/02 B25B13/56

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 B25F B25G B26B B25B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 384 499 A (C.SHOCKLEY) 24 May 1983 see column 2, line 60 - column 3, line 6; figures	1,26,28
A	WO 83 01406 A (MASCHINENVERTRIEB KOHLBRAT & BUNZ G.M.B.H.) 28 April 1983 see page 6, line 26 - page 8, line 12; figures 3-7	1,26,28
A	US 3 943 801 A (H.P.YATES) 16 March 1976 see column 2, line 55 - column 3, line 1; figures	1,26,28
A	US 2 804 970 A (A.KUC) 3 September 1957 see claims; figures	1,26,28
A	US 5 320 004 A (C.-Y. HSIAO) 14 June 1994 -/-	

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

21 May 1997

Date of mailing of the international search report

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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A	<p>FR 787 512 A (SAVARIN ET VVE FOINANT) 24 September 1935</p> <p>-----</p>	

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